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'Science', how is it formed?

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Abstract:

The purpose of this conceptual research is to determine the process of science formation and evolution. The method adopted in this study is based on documentary analysis. The research community included texts and researches related to the field of "Science", "Research" and "Technology". The scientific documents were selected using a purposive sampling method for analysis. In this paper the three concepts of: science scope, science band and science cycle are extracted from the findings of the reviewed materials for the first time ending in the following findings. Here the science scope consists of nine elements, the science band constitutes the space for science formation and evolution and the science cycle consists of a science network with seven categories and a science path with two procedures. The theme here is so vast that these findings may not completely meet the response to the question addressed, therefore more serious attempts should be made in this context.

Keywords: Science, research, technology, science formation, research formation, science evolution

1. Introduction

What is science? Where is its origin? What is its application and effects? These and many other specific questions lead to a very comprehensive questions of which are the fields of study of science (science of science)? All of us are more or less familiar with the oldest disciplines of science, such as *philosophy of science*, *history of science*, and *sociology of science*. Nowadays, the circle of studies regarding science is far beyond these three concepts, for example: classification of science, science policy, evaluation of science, science management, applying science, popularization of science, psychology of science, anthropology of science, geography of science, scientists, etc.

Next to science, another term that occupies our minds is *research*. Today, the role and impact of research in advancing human societies attributed to the well-being of mankind and the recognition of nature is indisputable; consequently, scholars are faced with serious questions about the concept of research, *philosophy of research*, *history of research*, etc. Given the importance of research in human life and assisting him to conquering nature, we are faced with a new field of research named *researchology* or *research science*. Researchology has the sub-fields like: research policy, research management, research evaluation, sociology of research, methodology of research, commercialization of research, ethics in research, etc.

While studying the nature of science and research and their assessments and evaluations, we encounter a big challenge: The essential questions that always flitter our mind consist of: Science, how is it formed? Is science measureable? Of course, these two questions are addressed by many philosophers, scientists, scholars, and researchers.

In this context, the emphasis here is in the first question; therefore, there is no doubt that the process of science formation and evolution is not specific to the general public, while for the vast majority of researchers, it is. Although even think-tank Latour *(1987)* has addressed this issue in a particular context, his theory does not have the necessary degree of completeness (exhaustivity) and ambiguity (exclusivity), not allowing to the reader to understand the formation of science in its real sense. This paper intends to answer this fundamental question. Of course, the answer to this question is subject to answering one other question. Here it is sought to answer the following questions in a deductive manner:

1. *Science*, how is it formed?
2. What is the difference between *science* and *research*?

2. Methodology

This is a conceptual research article exploring the process of science formation .The method adopted in this study is based on documentary analysis. The research community included texts and researches related to the field of "Science", "Research" and "Technology". The scientific documents were selected using a purposive sampling method for analysis.

3. Finding

In this section, the research findings are explained based on two research questions: one main and one sub.

3-1. What is the difference and borderline between science and research?

One of the great problems of institution of science is the wandering in the correct explanation of the concepts of science, research and technology together with their peripheral issues. The problem arises from the fact that some researchers still do not believe that science and research are two different concepts but relevant; therefore, it is not unreasonable for them to consider science as an article, research output, research project, research, or research activity. Really, what is *science*? What is *research*? And what distinguishes them?,!

In explaining these two concepts, it should be noted that research is the systematic process of discovering statements and scientific findings beginning from formation stage of a research problem or scientific speculation to the publication of the manuscript. Conclusions or findings of a research may be presented in the form of outputs like articles, books, patents, lectures, notes, technologies, etc. All these outputs require the approval of the science network even at a very limited level. The confirmation in science network is of different stages and shapes; therefore, it may be made by a team of researchers, colleagues, peer reviewers, reviewers, citation and references or testing stage, proofs, and arguments considered as uncertainties in science. Up to now, the publication of research results in any form, even subject to most accurate review do not justify science alone, and if asked why?, the following two cases will provide the appropriate answers:

First, I would like to point out the *hoax/experiment* that Alan Sokal, a physicist at the New York University, run in 1996:

> Sokal sent a paper entitled 'Transgressing the Frontiers: Towards a Hermeneutic Interpretation of Quantum Gravity' to the journal Social Text. The paper was unhesitatingly published by the journal, even though it was a mishmash of gibberish on physics and mathematics, simply because – according to Sokal – 'a) it sounded good, and b) it flattered the editors' ideological preconceptions'" (Bucchi 2004, 93). Even Nobel physicist Steven Weinberg "admitted that he was unable 'to judge what (this experiment) proved' (Bucchi 2004, 94).

Second, it is worth pointing out the *hoax/experiment* that William Epstein run in 1987:

> Epstein submitted an article in two different versions, but based on the same statistical data, to 147 social work journals: 74 of these journals received the article with a 'positive' conclusion (the social intervention had worked) and 72 received the one with the 'negative' conclusion. The first version was much more frequently accepted for publication, but when Epstein revealed his experiment, the reactions were much more violent than those provoked by Sokal's. It was even proposed that he should be struck off the professional register for using the journal editors as unwitting 'guinea pigs', and for breaching the principle of trust on which academic work is based (Bucchi 2004, 95).

So the two cases above reveal:

- The peer review of research outputs does not always mean its quality assurance.
- The passage of any research output from a referee's standard, either for the purpose of in the printing or confirmation, is not considered as *science*.
- The political, social, cultural elements, etc., are not affected by the publication of the article in the given journal.

These examples are necessary to design the following two logical theorems:

- *Any output of research is not science*.

- *Any finding of research is not science*.

As for *science*, although some people conceive the same meaning as scientific field, knowledge, scientists activity, technology, scientific method, scientific statements, etc., and the four other interpretations (as the article, research output, research activity, and research project), *science* is the set of theorems or statements obtained from the path of research or of the trial and error which are accepted in the *science network*. What is important in this definition, relates to science network, which depends on many elements and factors. Bruno Latour, a well-known French sociologist, addresses this issue, by saying: *A scientific statement or a finding can only acquire the status of 'fact', or conversely of 'artefact', if a complex network of actors – beginning with research colleagues who cite your finding or criticize them – pass it from hand by hand* (Bucchi, 2004 71).

The pre-reviews, peer reviews, discussions, revises, meta-analyzes, systematic reviews, reflections, re-examinations, scientific controversies, scientific confrontations, and citations are part of the process forming the *science*. In order to better understand the term *science* and prove the process thereof, the following four cases are introduced:

- The discovery of *cold nuclear fusion*. According to Bucchi *(2004)*, in 1989, more than 60 laboratories around the world officially announced that they had replicated Pons and Fleischmann's experiments and realized 'cold' nuclear fusion
- The *Diffusion of Innovation Theory*, introduced in 1962 by a famous American communications expert, Everett M Rogers, has led to many studies around the world. Midgley (1987) run a meta-analysis on more than 1800 research results, where the findings of either approve or reject some of Rogers' views. Finally, Rogers accepted

some of the criticisms in the new edition of the book and corrected the theory. Today, this book is the first most cited book in the social sciences with 102,167 times citation according to Google Scholar.

- The attribution of two Nobel Prize winners to physiological discoveries proved to be false in science: one awarded in 1903 for discovery of phototherapy, and the other in 1927 for treatment of dementia paralytica (Bucchi 2004).
- The errors and mistakes made during a research, in addition to manipulations, bias, non-disclosure of results, methods, etc. is difficult to understand for upcoming evaluators or researchers. According to Merton (1968, 4):

> …the rock-bound difference between the finished versions of scientific work as they appear in print and the actual course of inquiry followed by the inquirer. The difference is a little like that between textbooks of 'scientific method' and the ways in which scientists actually think, feel and go about their work. The books on method present ideal patterns: how scientists 'ought' to think, feel and act, but these tidy normative patterns, as everyone who has engaged in inquiry knows, do not reproduce the typically untidy, opportunistic adaptations that scientists make in the course of their inquiries. Typically, the scientific paper or monograph presents an immaculate appearance which reproduces little or nothing of the intuitive leaps, false starts, mistakes, loose ends, and happy accidents that actually cluttered up the inquiry.

In addition to what is discussed in this context, there exist new phenomena like predatory journals, hijacked journals, fake peer review, fake conference, etc. for example, David Moher et al. (2017) revealed how harmful predatory journals are in medicine and related fields (Donovan 2017). According to Moher et al. (2017), there roughly exist about 8,000 predatory journals that collectively publish more than 400,000 items a year (Shen and Björk 2015). Accordingly, it could be deduced that: 1) not all outputs of research are *science*, 2) not all findings of researches constitute *science*, 3) research and science are of a multi-stage process, and 4) research and *science* are distinct from each other. Of course, Latour (1998, 28) has clearly identified the boundary between science and research:

> *Science* is certainty; research is uncertainty. *Science* is supposed to be cold, straight, and detached; research is warm, involving, and risky. *Science* puts an end to the vagaries of human disputes, research creates contro-versies. Science produces objectivity by escaping as much as possible from the shackles of ideology, passions, and emotions; research feeds on all of those to render objects of inquiry familiar.

For approval of uncertainty of research, would suffice: the relation between egg and human health. What people really should do? In one study, it is announced that one should not eat more than two eggs per week; in the next study, eating an egg a day is a recommended, and yet in another one it is announced that high consumption of egg is dangerous for the patient with cardiovascular disease, while another suggests the cardiovascular patient should eat an egg a day….

The other case of the uncertainty of research is the science wars, for example, the question of the velocity of light. According to Hacking (2000, S64):

> One dreadful argument in the "science wars" goes like this: The velocity of light is a fundamental constant of nature. It is about 186,282 miles per second. We know the actual value to a very high level of exactness. This number is completely independent of any social circumstances whatsoever. It happens that all the major contributors who have helped to determine this number to several places of decimals are dead white males, but essen- tially the same measurements would have been obtained if the investiga- tors had been women or Polynesians….

As already mentioned, the output of research consists of statement(s) or finding(s) that can result in fact or artifact. Although fact and artifact both are science in a sense, the latter is crystallized science or in modern terms, the *technology*; consequently, if this technology enters into another process that involves mass production, industry is formed. In fact, this is the Bacon's science. In parallel to Bacon's science, encountering Aristotelian science which is nothing but science for science is inevitable.

The correlation among science, research, technology and industry is flowcharted in Fig. 1.

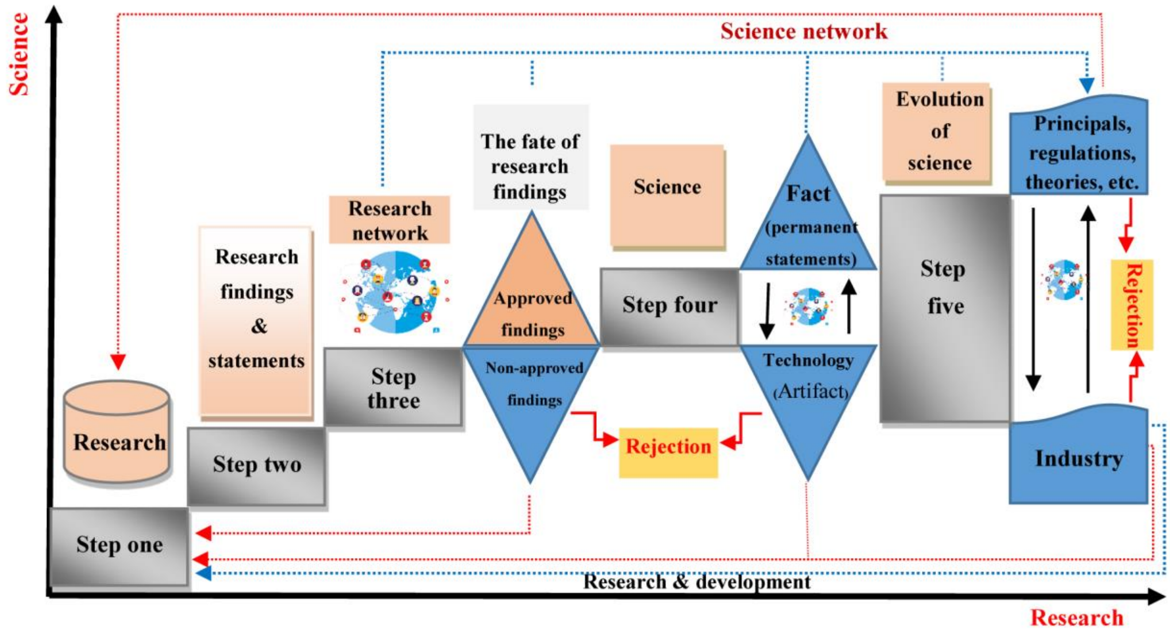

Figure 1. Separation of the areas of research, science, technology and industry

3-2. 'Science', how is it formed?

As observed in Fig. 1., technology is derived from science and science is formed on the research path. This attitude is the same as that of the reflexion of Bacon and Baconism: an idea that adheres to beneficial science and necessitates the development of technology from science in order to *increase of man's control over nature, and the comfort and convenience of humanity* (Bacon, 2009, 5). So for Bacon, science is the main source of inventions that improve human life.

Of course, in addition to the path of research, science is formed once through research and once through trial and error (by accident). Nevertheless, in today's world science is formed through the technology and technology on its own, is the outcome of trial and error, Fig. 2. There exists the strong historical evidences that technology is not a product of scientific knowledge, while the knowledge of technology has led to scientific knowledge which provides the grounds for the emergence of new scientific theories and principles.

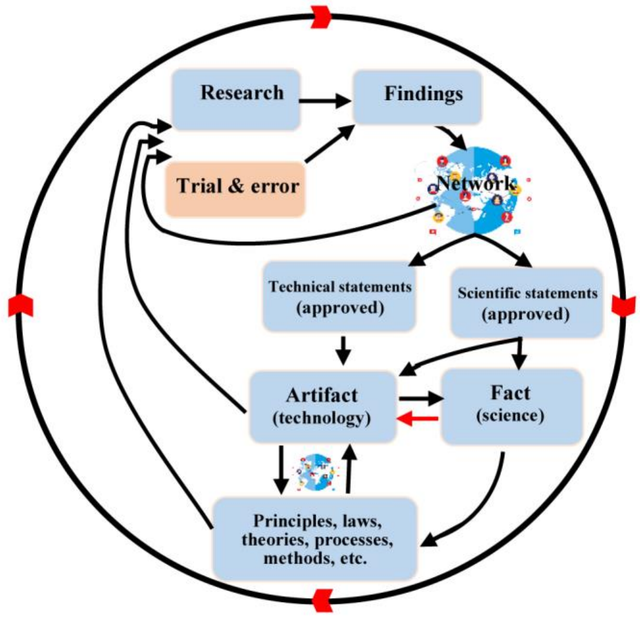

Figure 2. Determining paths of science in science cycle

In this context, the examples include steam engine, water turbine, dynamite, radioactivity, nylon, Cosmic Microwave Background radiation (CMB), and personal computers. Among the most notable accidental inventions, the invention of the water turbine and steam engine are renowned. Researchers like Cardwell (1965), Layton (1979), and Reynolds (1979) believe that water turbine was invented by accident. Therefore, as found in Cardwell's studies, introduction thermodynamics concepts was due to the invention of the steam engine. Likewise, *the problems encountered and the solutions adopted by technicians to develop motors prompted the reflections which led Carnot to formulate his general principles of thermodynamics* (Barnes and Shapin, 1979; Layton, 1988 cited in Bucchi (2004, 81).

That's the point that Lawrence Joseph Henderson claimed in 1917:

> Science owed more to the steam engine than the steam engine owed to science. he was thinking no doubt of its stimulus to thermodynamics and of Carnot's and Rankine's cycles and he was forgetting that Watt's flash of inspiration which produced the condensing engine was derived from his friend Black's discovery of latent heat. This example of the interplay of discovery and invention is typical of the evolution of machines and techniques both to meet and provoke the demands of modern society (Hartley 1961, 137).

Here, it is concluded that the relation between scientific knowledge and technological knowledge is a two-way relation; in other words, on the path of scientific knowledge to technological knowledge, in some cases scientific knowledge can also be obtained from the knowledge of technology Fig. 3. So, as science affects technology and advances it, technology affects science and advances it.

Figure 3. The correlation between scientific knowledge and technological knowledge

With respect to what is said up to now, the grounds are proposed for answering the important question: the title of this paper. The process of forming science is very complex, because here both scientific paradigms and science in the field of natural sciences, humanities and social sciences, etc. should be of concern. The contributions of individuals and research groups, private and public sectors, science in the advancement of science and technology, and technology and industry in science are of concern. Here, the focus should be on the network of science and the factors involved in its constituent contexts. To have a more comprehensive and practical understanding of this process, the formation of science is subject to: 1) science cycle (inner circle), 2) science scope (outer circle), and 3) science band (middle circle), fig. 5.

Science cycle

Science consists of a cycle, where there exist different elements and phases, where, the findings are obtained from research path or through trial and error. These findings are re-examined, tested, criticized, cited, etc. in both the research and science networks. If approved in the research network, scientific or technical statements will result in fact or artifact. If this fact is endorsed in the science network, principles, rules, theories, methods, processes, etc. in science are obtained. Likewise, if the technology reaches mass production, the industry is formed and through industry, rules, principles, scientific methods, etc. will be approval or rejection in science. The key elements in the cycle of science consist of: findings, and science network:

Findings: Although the term finding(s) are applied in figs 1- 2 and 4 - 5, it refers to statements, ideas, and innovations.

Science network: The science network consists of a great circle and as observed in Fig. 4., it covers the grounds from findings to the final approval. The science network is dynamic and is subject to time and space. Moreover, this network is contributive in science; therefore, the findings may turn into science as a fact or artifact.

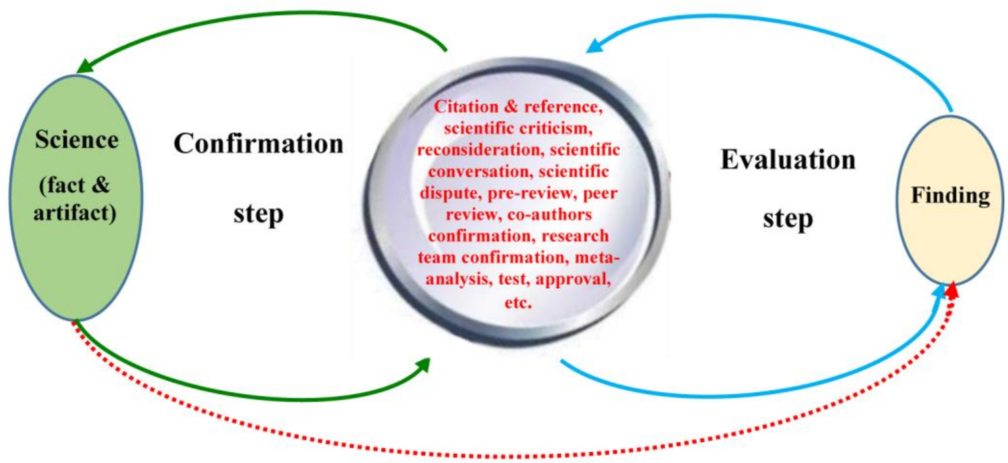

Figure 4. Science network

Approvals in science network are of seven different categories:

I. **The count of co-authors in scientific documents:** this count indicates a sign of collaboration as a part of the science network. Of course, the count of colleagues in the field of applied researches is much more than other fields. Up to date, the largest number of authors per article is related to a 33-page physics article, with 24 pages of 5134 authors and their organizational affiliation (Castelvecchi 2015). This article was published in Physical Review Letters on May 14, 2015 (Aad et al. 2015). In 2015, the Nature journal published an article with 2700 physics authors (CMS Collaboration and LHCb Collaboration 2015). In 2015, an article on the genome was published with 1013 authors in the Genes Genomes Genet journal (Leung 2015). In August 2008, an article in physics was published in Journal of Instrumentation with 3099 authors. In 2012, an article about Higgs particle was published with 2932 authors (ATLAS Collaboration 2012). Of course, the importance of these lists in science network is the count of authors involved in that project, this is a real partnership. In this context, reactions to some of these articles are evident. According to Woolston: *Genomics paper with an unusually high number of authors sets researchers buzzing on social media* (Woolston 2015).

II. **Initial judgment (pre-review), peer review, and cross review:** The purpose of the initial judgment is to obtain the informal view of the specialists about an idea or a document and or publication of the article in pre-publication databases, like ArXive, in order to get the comments of others and to modify the document before publication. The peer review increases the article's quality. Although the peer review is an essential part of the process of the formation of the science, it is not free of drawbacks, for example, Normile (2017) concentrates on 100 retracted articles from China: *Officials last week announced that more than 400 researchers listed as authors on some 100 now-retracted papers will face disciplinary action because their misconduct has seriously damaged China's scientific reputation". In peer review, we sometimes face a contradiction with the opinions of the referees on a document. The arbitration process in most journals is such that referees are not aware of the opinions of other reviewers* (Cross-review).

III. **Citation and reference:** The number of times a document or idea is cited or referred to is one of the approving methods in the science network, while not a definitive approval. According to Garfield (1979), the authors refer to previous material to support, illustrate, or elaborate on a particular point. Of course, a high count of citations is not always a sign of quality. For example, Rodgers' Diffusion of innovation book was widely cited until 1994, while many criticisms the years by Vedel (1994), Flichy (1995), Bardini (1996), Lundblad (2003) and others); him to accept some of these criticisms and revise his theory (2001).

IV. **Critics and reviews, conversations, notes, corrections, new editions, published correspondences, controversies and conflicts, etc**.: Each of these cases has a definite place in the science network.

V. **Research results on a topic:** Researches may be run in a simultaneous or separate manner on an issue, idea or a previous research finding. It is likely that some of these findings would be consistent with previous research results. This conditions are encountered in resource review studies, systematic review, meta-analyzes, and literature review in the published articles. As Midgley (1987) states:

> The 1840 published studies relating to 20 of Rogers and Shoemaker's generalizations on the diffusion of innovations are meta-analyzed by way of assumptions and simple techniques addressing sampling error. It is found that most of the discrepancy between studies supporting and not supporting these generalizations can be explained as statistical artifacts, and that there are likely to be correlations of order 0.20 between most independent variables

and time of adoption. Such correlations are capable of improving our success rate in predicting earlier/later adopters to 60% (for one independent variable).

VI. **Confirmation of members of the research team or owner of the intellectual property:** approval of findings by research team members (researchers and technicians) is the initial approving phase in science network. For example, in the CERN project, 22 countries, 10,000 scientists and engineers from 600 universities and research institutes of 100 different nationalities cooperate. In Celera Corporation, 554 researchers and technicians work together (About CERN 2018). Consequently, verifications will be conducted in most other research projects (public and private), in research and development programs of companies, institutions, factories, etc.

VII. **The experiment, testing, retest methods, repeatability, proof and argument:** In the texts of the philosophy of science, much has been and is being discussed about these topics. Here, we only refer to the decisive contribution of such cases in science network.

Among the seven categories mentioned above, I to V are of uncertainties, that is, the existence of either or the approved of scientific finding thereof or their combination is not a sign of final approval. In categories VI and VII, approval at colleagues level, in particular in the laboratory or through testing and re-testing methods, repeatability, argument, and proof is finalized although uncertain. The science network is illustrated in Fig. 4, where the findings can vary at two consecutive levels: 1) the initial assessment level, which includes one or more of evaluations: scientific discussion, scientific controversy, scientific critique, revision, initial evaluation, peer review, citation and referral, approval of the research team, approval of co-authors, meta-analysis, and 2) the confirmation level, which is based on the test, proof, argument, etc.

Approval findings that are either fact or artifacts are able to reject, modify, and replace any section in science network. Its feedback is shown in Fig. 4 in dotted curvatures and as observed, scientific findings that reach the final confirmation stage is named *science*. Consequently, with certainty it can be claimed that *science* is the common product of the efforts of past and present generations, which, of course, is a futuristic as to evolutionary contributions of upcoming generations.

Science scope

Science is formed in the context in which it exists or is provided for it. This is an inevitable fact that science is located and resorts to a space fit for. Therefore, it does not matter whether this location is a country or the mind of an individual, as George Sarton (Sarton 1952, XIII) says: *Science never developed in a social vacuum, and in the case of each individual it never developed in a psychologic vacuum*. according to Sarton (1952) and Dampier (1948), possibly, the scope of science was evolved from 600 to 300 BC, in Greece; from 600 to 650, in China; from 650 to 700, in China and India; from 700 to 1100, in Iran and the Arab world; from 1100 to 1450, in Europe, the Arab world, and Iran and from 1450 to 1950, in the Western world. Of course, since 1960, America, Europe, Russia, and Southeast Asia have become the scope of science where scientific culture is cultivated.

Today, some countries or individuals provide a platform for achieving science or be part of its advances. As to the countries at state level, in almost all, such set-ups as observed regarding military projects, physical, biological, medical, and astronomical research projects, research laboratories, expanding higher education, increasing research costs, commercialization of research, etc. To name a few, the mega research projects of CERN, Genome, Advanced Light Source (ALS), Large Hardon Collider (LHC), International Space Station (ISS), Neptune Canada Undersea Observatory (NCUO), Square Kilometer Array (SKA), European Space Agency, Plasma Physics Research Center, European Molecular Biology Laboratory (EMBL), European Southern Observatory (ESO), and European Synchotron Radiation Facility (ESRF) are the living samples. All of these are examples of launching pad of science. At personal level, as Pasteur claims that*: In the field of observation, chance favours only the prepared mind* (Today in science history 2018). Consequently, Elon Musk in SpaceX is a launching pad of science where *he oversees the development and manufacturing of advanced rockets and spacecrafts for missions to and beyond Earth orbit* (Musk 2018).

In addition to the above, science scope consist of: economic, political, social, environmental and cultural, scientific, industrial and technological, managerial, and commercial elements, dimensions and contexts. The correlation among these eight elements with science is a kind of cross-relation and interconnectedness. For example, the science affects economy and economic structures, and economy affects science.

- **Economic elements, dimensions and context**: The formation of science, its growth and development are closely related to economic elements, dimensions and context. Today, scientific activity is a profession and the maintenance of its occupants that is the scholars and scientists is costly. Launching research projects at both micro and macro levels will require heavy fundings and costs. Economic progress, prosperity, and budget have a profound effect on the formation of science, its growth and development.
- **Political elements, dimensions and context**: Political elements and context are highly contributive in the formation and development of science. The type of government, political structures, science and research administration and management, the support of politicians from science and research, the

competition of governments, the efforts of governments to preserve national resources and defense against invasion, etc. are very influential in the formation and advancement of science. Therefore, military research projects in most countries are supported by politicians. The world does not forget the support of politicians from major research projects like Clinton and Blair's support for genome project in 2000. Of course, it is necessary to note that projects that pursue political support, although effective in advancing science, have not always benefited humanity.

- **Social elements, dimensions and context**: Science is the product of the given communities social appreciate of science.
- **Environmental and cultural elements, dimensions and context**: Science generates scientific culture and scientific culture promotes science.
- **Scientific elements, dimensions and context**: The scientific scope of mankind today is unprecedented in history. Thus, the discoveries and inventions, the extensive education and promotion of science on a global scale, the count of significant researchers and scientists in the world, the count of journals, books, patents and other resources, the count of international conferences and seminars, the widespread sharing of scientific knowledge, facilitating international collaboration, collaborating on international projects like CERN, the Web environment, databases, libraries and large scientific archives, the convenient and fast transfer of knowledge to the society, the correlation among scientific ideas, the count of critique journals, competition and cooperation in science, scientific prizes, etc., all constitute the material evidence of the availability of the scientific scope of science. All of these are indicative of this universality of the phenomenon and the affirmation of Pasteur's announcement: *if science has no country, the scientist should have one* (Today in science history 2018).
- **Industrial and technological elements, dimensions and context**: Science advances technology and industry, as technology and industry promote science; consequently, the technological and industrial platform are influential in the formation and development of science. Today, scientific research tools, laboratory equipment, information and communication technologies, technological environments, industrial environments, etc. are provide the scope of science. A researcher or scientist who does not have the necessary scientific and technological tools for research and experiment is like a cook without a knife, as Pasteur says: *without laboratories men of science are soldiers without arms* (Today in science history 2018).
- **Managerial elements, dimensions and context**: There exist strong scientific and

historical evidences indicating the contribution of managerial elements in the formation and growth of science. Effective management of research and research centers, policies and planning in research and industry, launching macro research projects, correct spending of the budgets thereof, directing scientific and technological researches, continuous monitoring of educational and research centers, project management, drawing and observing laws and regulations in facilitating and contributing of research and science, etc., contribute to the formation and development of science in a given country.

- **Commercial elements, dimensions and context**: As defined by Etzkowitz and Webster (1995), research results is private property. It is clearly observed that discovery in science and technology and their development by scientists and/or such organizations is a costly endeavor for countries, research centers, industrial centers, individuals, etc. After achieving science and technology, the first thing they do pattern and register this findings. Then, with the sale of technology and product, they seek to reimburse the costs incurred, and once more through that money, they develop science and technology. There exist many vivid and concrete evidence in this context.

Science band

The intermediate circle is the science band that connects the cycle of science and the scope of science. In fact, it is the place and space where science is formed.

The process of science formation is illustrated in Fig. 5.

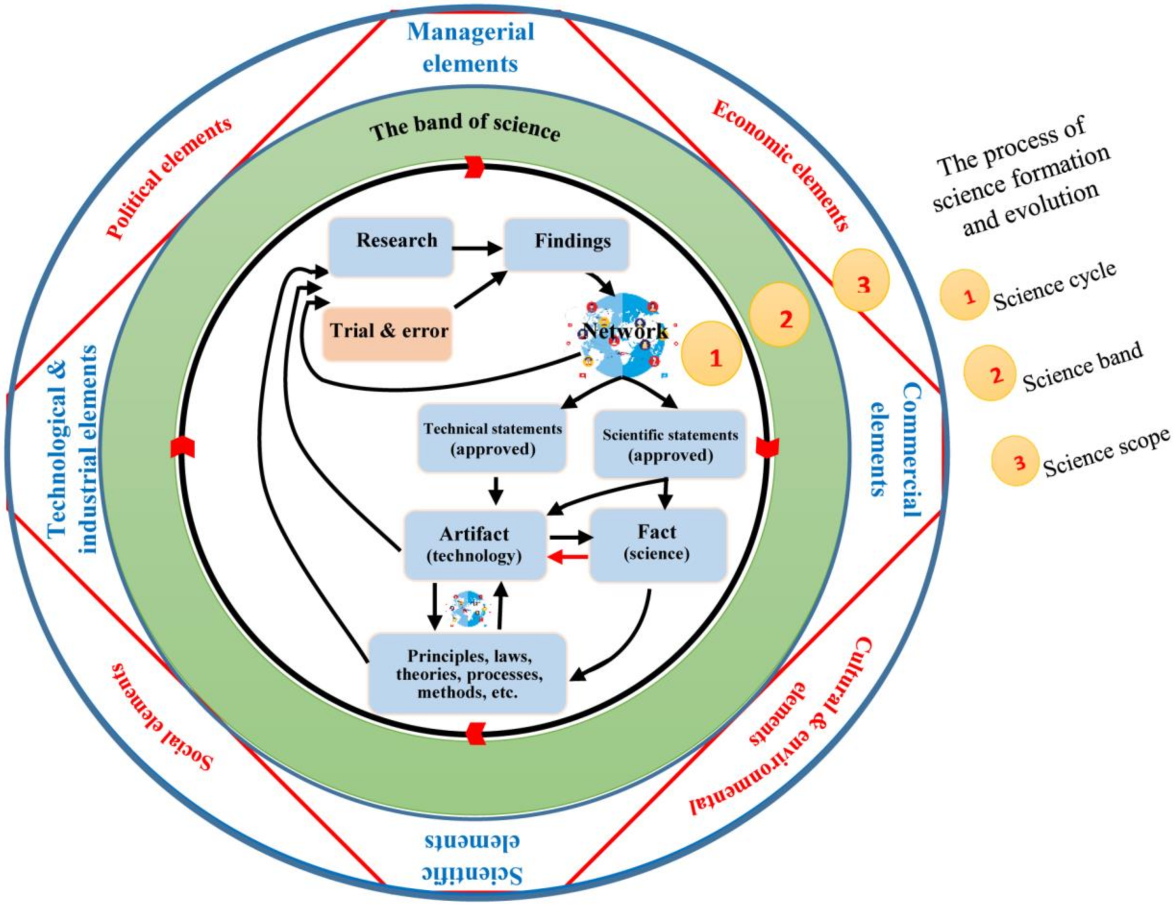

Figure 5: The process of science formation

4. Conclusion

The results indicate that human beings pursue two main objectives through science: answering their most fundamental questions, as in the CERN project, where scientists seek to find manners to shape the world and matter and, to achieve quietness, comfort, prosperity, health promotion and ultimately a better life. It can be claimed that science is formed in a cocoon made of research and trial and error, while in turn function through the three science network, science cycle and science scope process.

Approvals in science network are of seven different categories: 1)The count of co-authors in scientific documents, 2) Initial judgment (pre-review), peer review, and cross review, 3) Citation and reference, 4) Critics and reviews, conversations, notes, corrections, new editions, published correspondences, controversies and conflicts, etc, 5) Research results on a topic, 6) Confirmation of members of the research team or owner of the intellectual property and 7) The experiment, testing, retest methods, repeatability, proof and argument.

The science scope consist of: economic, political, social, environmental and cultural, scientific, industrial and technological, managerial, and commercial elements, dimensions and contexts.
The marginal results are briefed as:

- *Science* is generated based on two paths: research and trial and error, where in both, the formation of science is a process.
- *Science*, unlike research, has a certain degree of certainty; therefore, some findings or statements of research in the science network have the potential of being converted in to science.
- Not all outputs of research are *science*, not all findings of researches constitute *science*, and research and science are of a multi-stage process
- A high degree of citation on a manuscript, high impact factor (IF), numerous co-authors on a manuscript, published manuscript after peer review, etc. do not always guarantee the finished product. Additionally, although they are valuable, none of them is the ultimate confirmator element of the findings in science network.

In this article, a framework is devised to reveal the formation and evolution of science through the three features of science cycle, science band and science scope.

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